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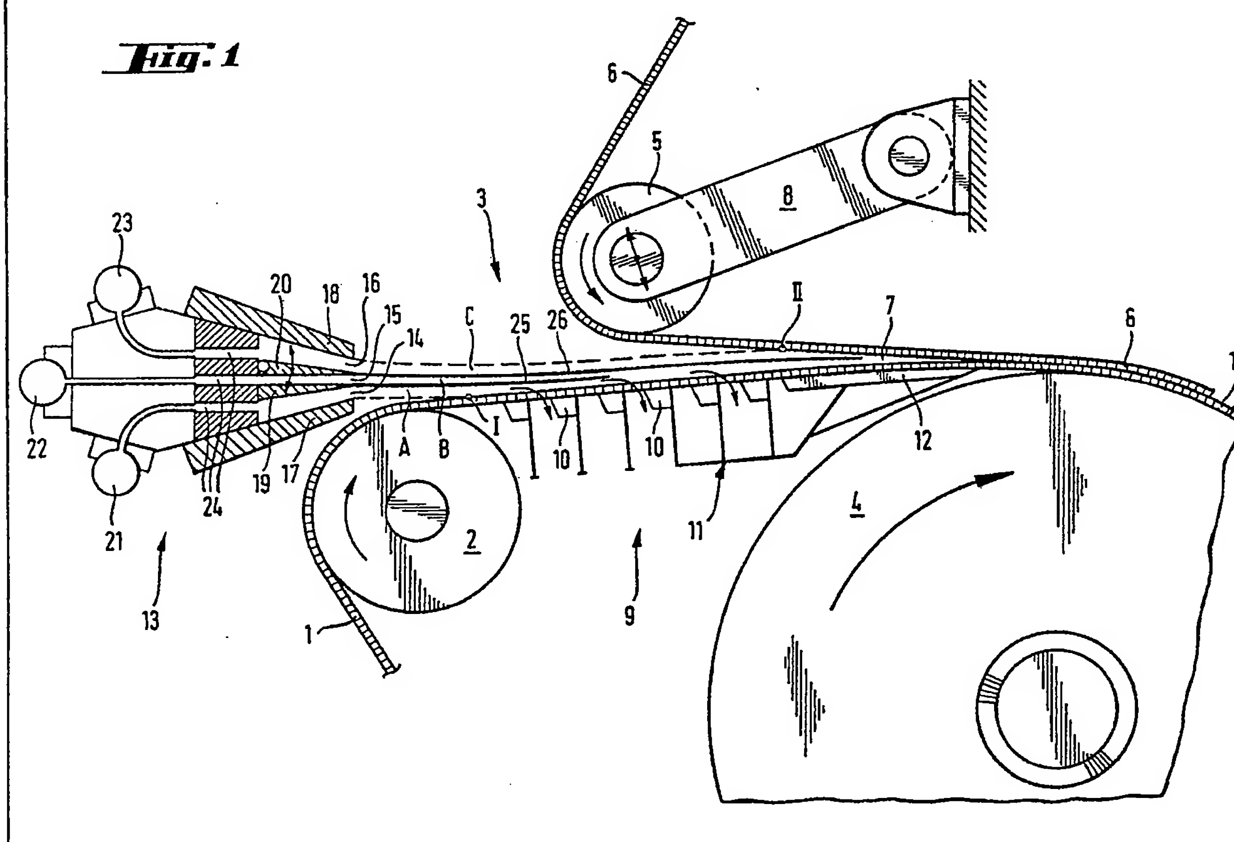
(54) Methods and apparatus for forming a multi-layered paper web

(57) A double wire former for multi-ply paper or board and having a number of headbox outlet apertures (14, 15, 16). Three streams of stock (A, B, C) are kept separate by partition components (25, 26) even after leaving the headbox outlet apertures (14, 15, 16). At least the first stream (A) is pre-dewatered in a pre-dewatering zone (3) of the first wire (1) before all the streams (A, B, C) enter the gap region (7) between the two wires (1, 6) between which at least the last stream (C) experiences initial dewatering. It is thus possible separately to influence the predewatering of the individual streams of stock for forming sheets.

Fig. 1



The drawings originally filed were informal and the print here reproduced is taken from a later filed formal copy.

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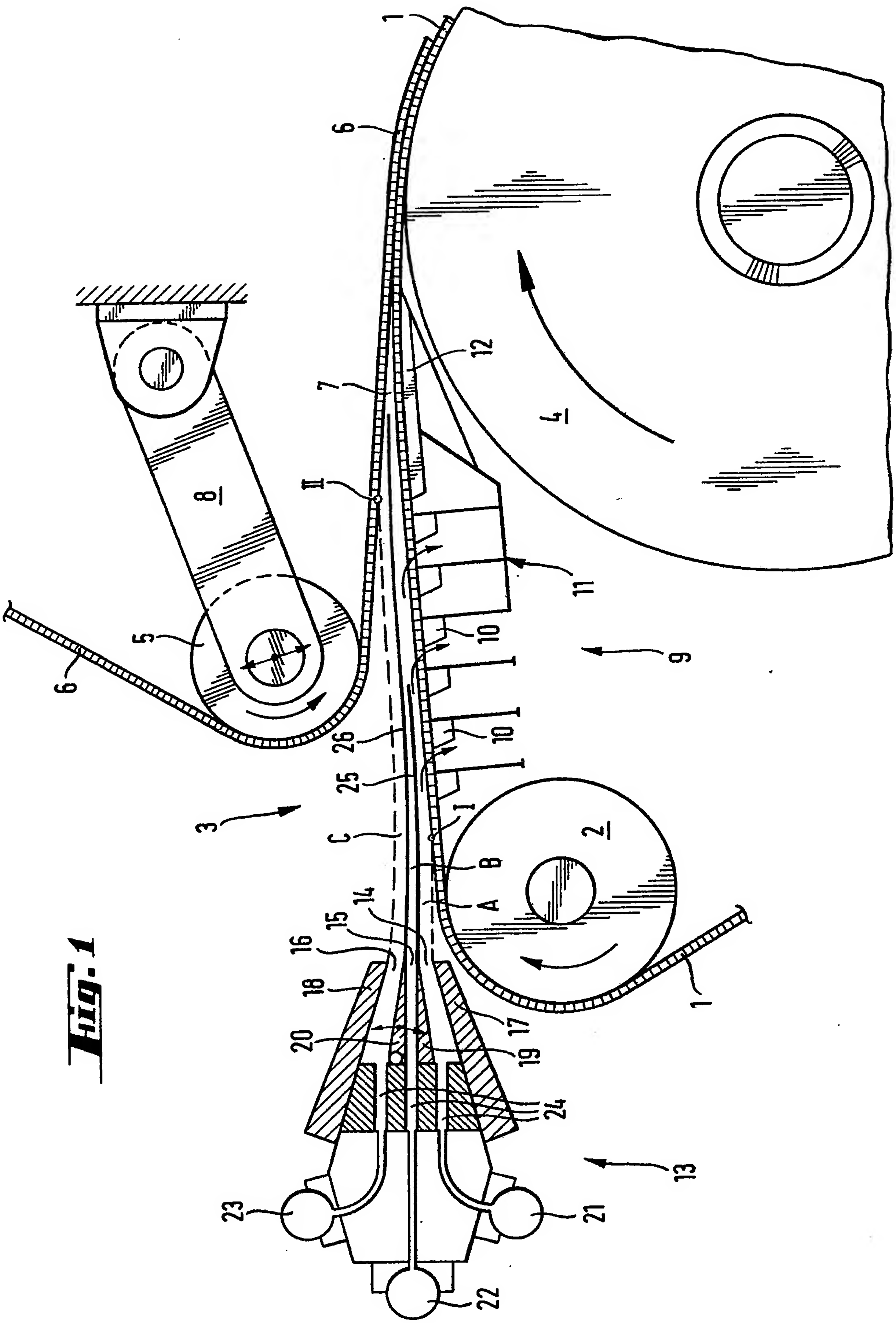

Fig. 1

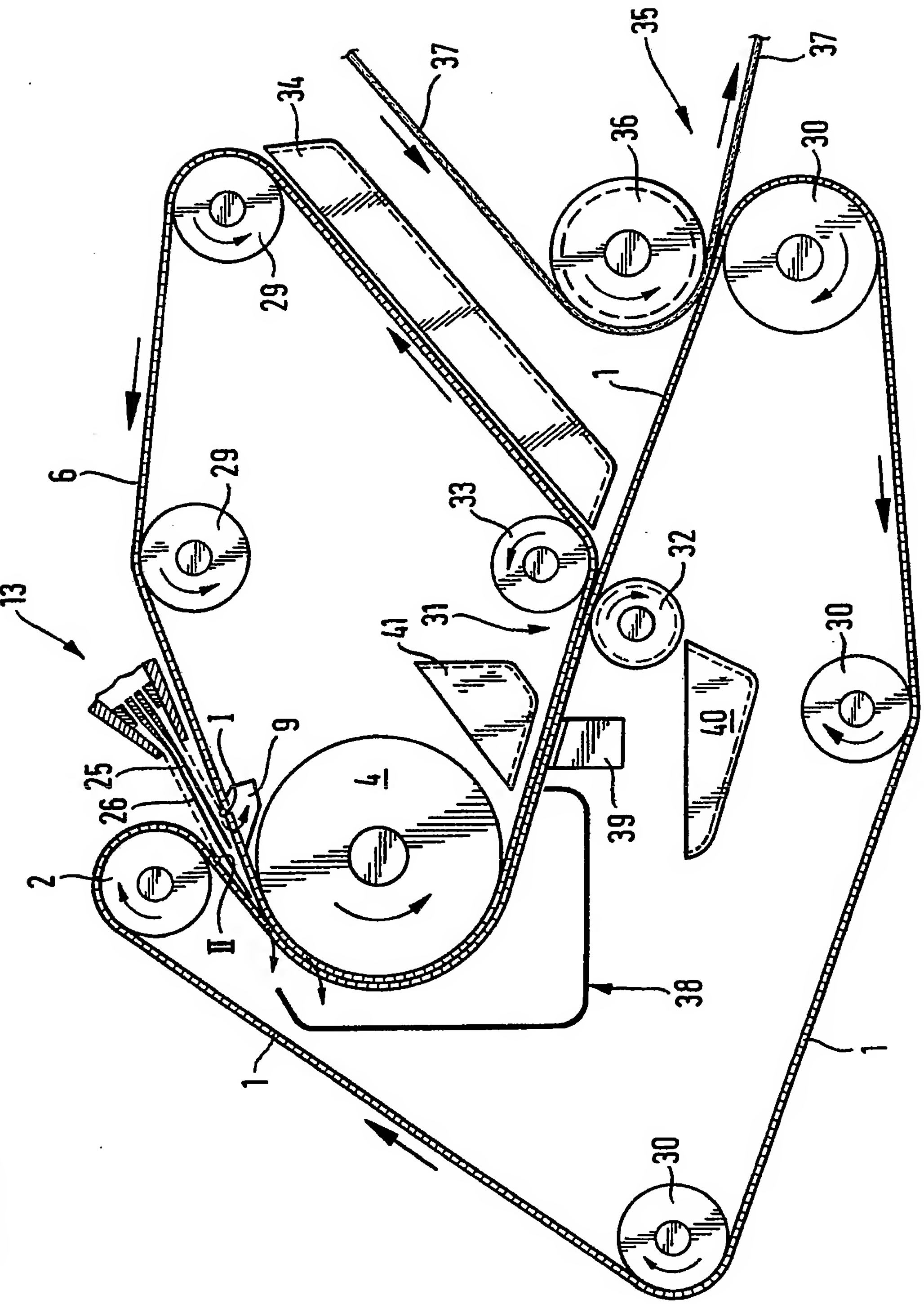
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Fig. 2

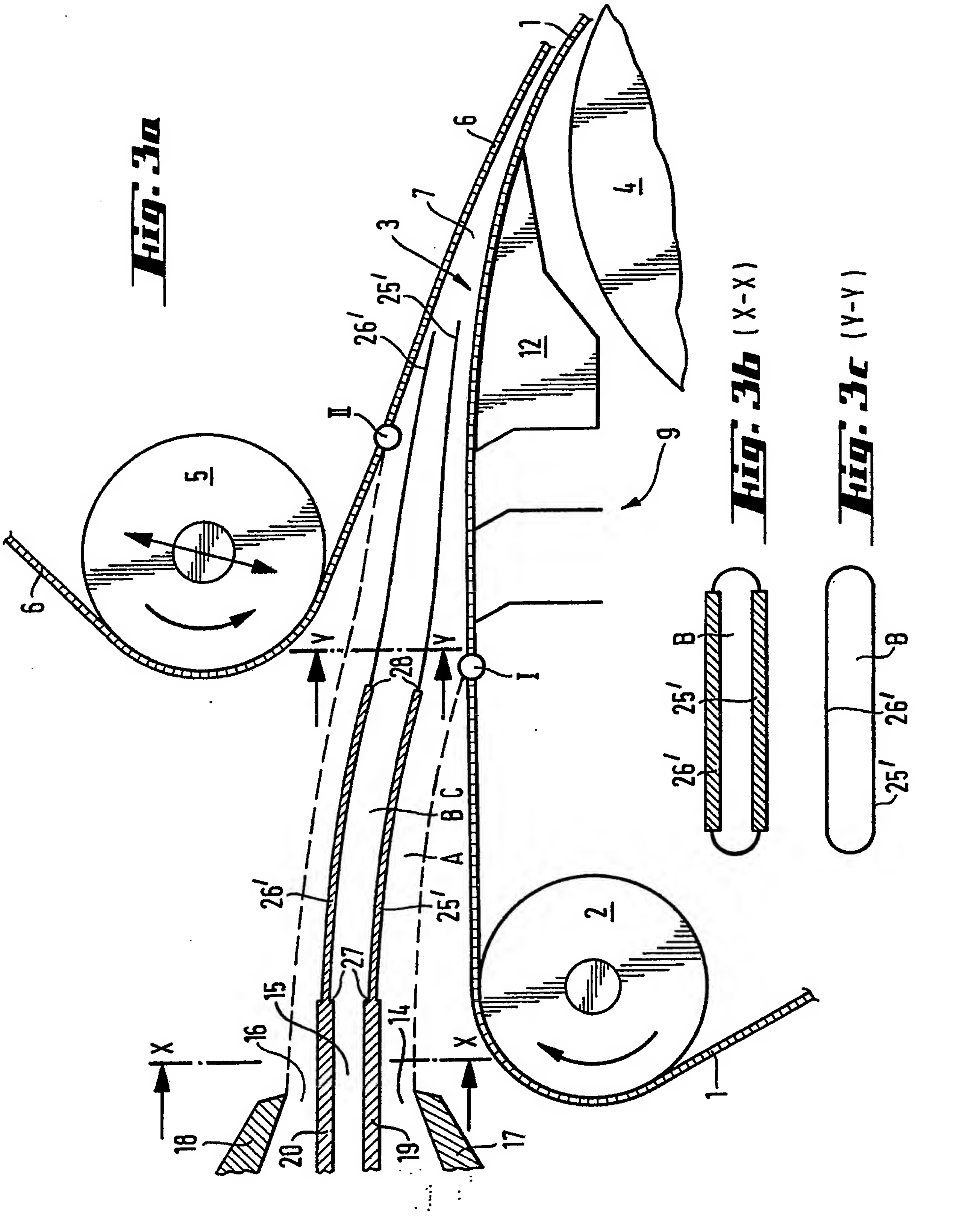
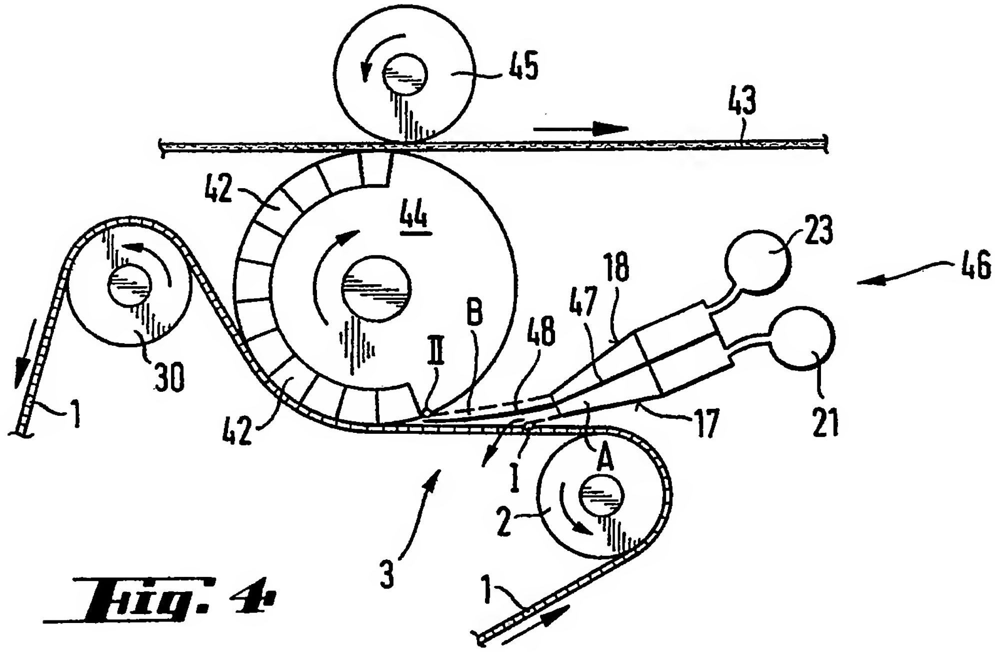


Fig. 3a

Fig. 3b (X-X)

Fig. 3c (Y-Y)



45
43
42
44
23
46
18
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30
II
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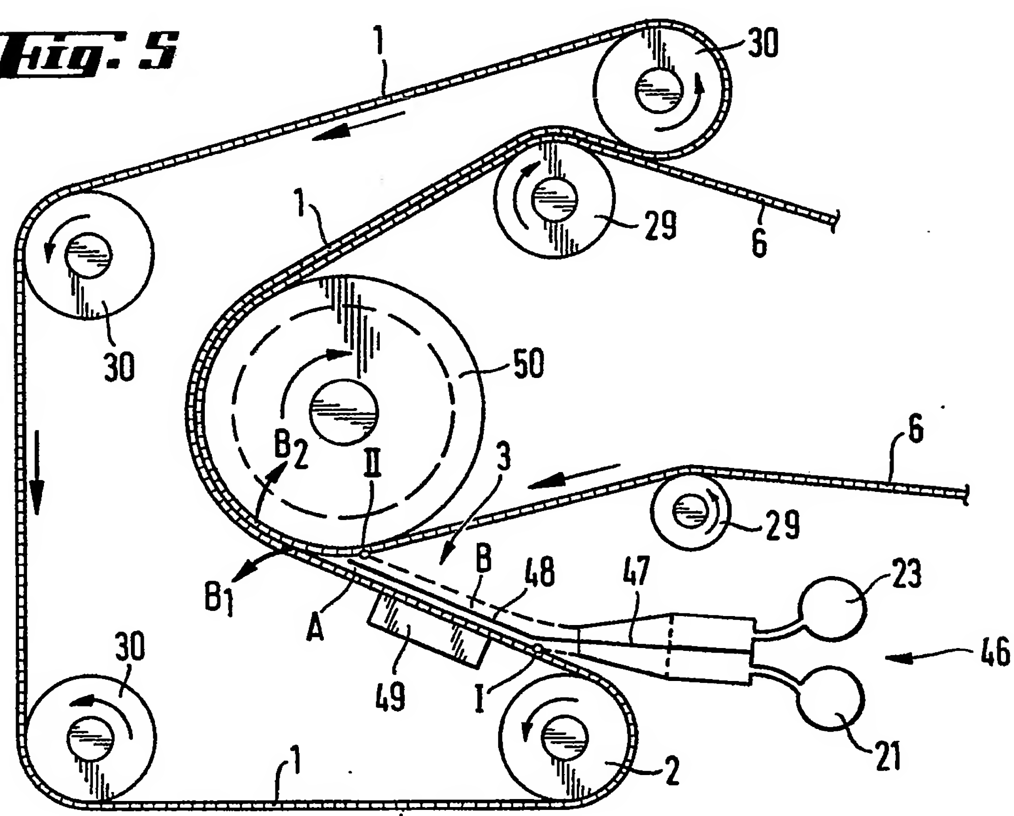
42
17
21
A
I
2
3
1

Fig. 4

Fig. 5



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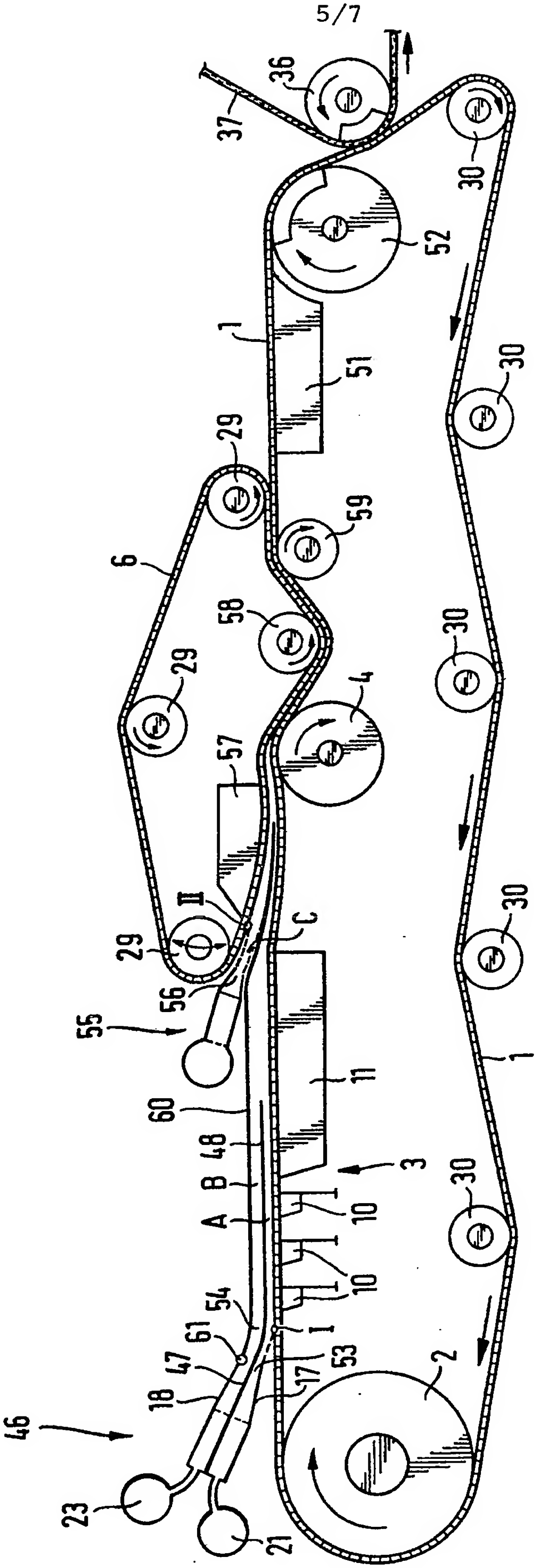
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C
I
II

Fig. 6

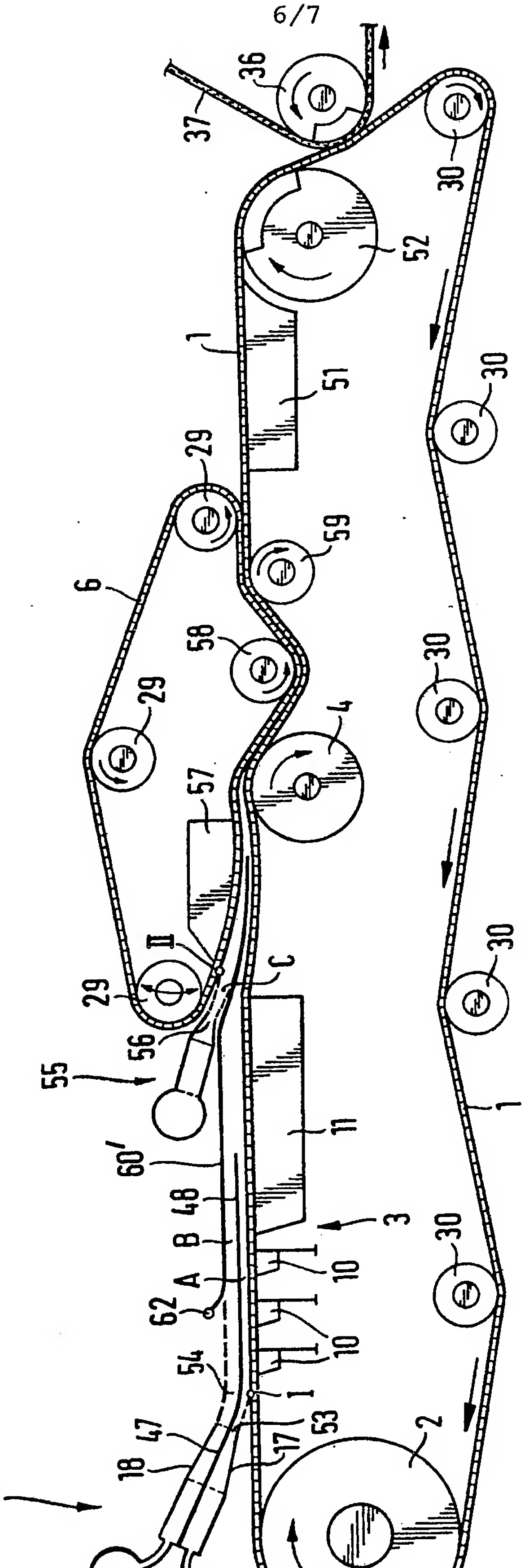

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Fig. 1

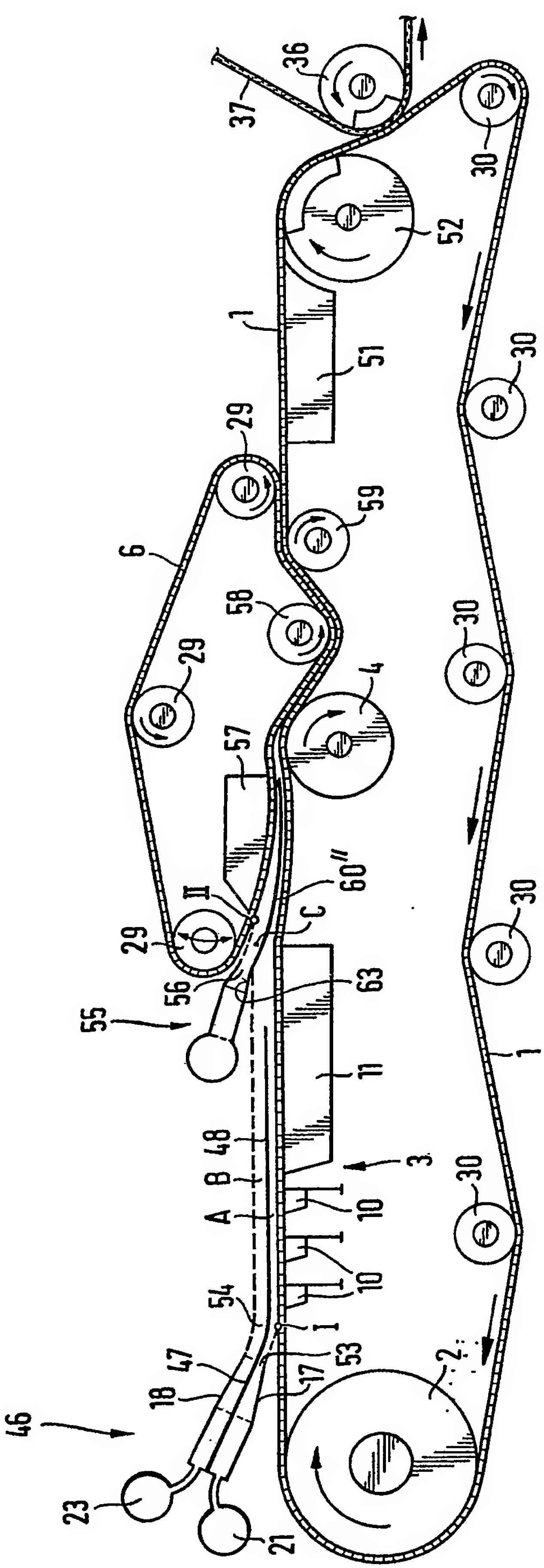
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Fig. 8

SPECIFICATION

Methods and apparatus for forming a multi-layered paper web

This invention relates to a method of forming a multi-ply paper web in a double wire former comprising first and second endless wires, parts of the wires being pressed together under tension and travelling through a curving zone producing a dewatering pressure and forming a converging gap at the inlet to the curving zone, the gap receiving a paper web being manufactured, and at least two streams of stock emerging separately from headbox outlet apertures and being guided in substantially neighbouring layers and kept separate from one another for a distance by partition components extending in the flow direction downstream of the outlet apertures. The present invention also relates to a double wire former for a paper machine comprising headbox means having at least two separate stock supplies and a corresponding number of outlet apertures bounded by walls extending generally parallel to the flow and across the width of the headbox outlet apertures, partition components between the streams of stock and holding the streams apart for a distance downstream of the outlet apertures, and first and second endless wires which co-operate to partially surround a dewatering roll and, at the place where they touch the dewatering roll, form a converging gap for receiving the paper web under production.

Apparatus for producing layered or plied paper webs is increasingly in demand, in order to use raw material of varying quality distributed through the cross-section of the paper web. The usual method of achieving this hitherto has been to use secondary headboxes over the wet part for depositing an additional layer of web on an already-formed layer. Today, owing to the improved bonding between layers, the aim is to apply a steam of stock for a subsequent layer on to a preceding layer before it has been completely formed. In order to reduce the cost of equipment, attempts are usually made to obtain the different stream of pulp from a single headbox, which is correspondingly sub-divided for the purpose or can be so subdivided if necessary. Multi-layer headboxes are usually necessary, particularly in double wire formers, which are coming increasingly into use and are designed for very high speeds, since there is often insufficient space for a secondary headbox.

A device of the initially-described kind is described, for example, in US-PS 4 141 788. In the device there described, the stream of stock, which is divided into three separate individual streams by partitions in a stock feed channel, is conveyed directly, in a substantially symmetrical system, into the converging inlet gap between a double wire. The two flexible, self-aligning partitions between the three streams of stock extend across the outlet aperture of the headbox into the converging inlet gap between the wires, so that the central stream is dewatered at a later stage, but the two outer streams come immediately into contact with the corresponding wires and are dewatered by the converging gap. In another device described in the same specification and showing how the corresponding headbox is applied to a double wire former with a closed forming roll, the webs of stock are dewatered on only one side and so that partitions are given different lengths, but as before the total stream of stock directly enters the convergence region between the two wires, so that the total dewatering pressure is determined by the shape of the gap region.

Similar systems, but in which the partitions between the streams do not project beyond the outlet aperture of the headbox, are described, for example, in German OS 29 16 351, US-PS 3 923 593 and US-PS 4 181 568.

The object of the present invention is to provide a method of forming a multi-layered web of stock using a double wire former in which the individual streams or layers of stock can be separately dewatered under different conditions over a sufficiently long distance, but the individual streams are kept substantially separate.

According to a first aspect of the present invention, a method of forming a multi-ply paper web in a double web former comprises first and second endless wires, parts of the wires pressing together under tension and travelling through a curving zone producing a dewatering pressure and forming a converging gap at the inlet to the curving zone, the gap receiving a paper web being manufactured, and at least two streams of stock emerging separately from headbox outlet apertures and being guided in substantially neighbouring layers and kept separate from one another for a distance by partition components extending in the flow direction downstream of the outlet apertures, at least the first stock flow adjacent a first of the two wires being pre-dewatered at the first wire without action by the second wire and by the dewatering pressure of the curving zone to form a completed layer of paper web, and at least the last stock stream, which is guided by the last partition component and is not externally bounded by a partition component being dewatered by being inserted directly into the converging gap region formed by the wires.

If required, the streams of stock striking the first wire in front of the converging gap region can be very gently dewatered by the first wire, as a result of the static pressure of their own heads of liquid. Alternatively, dewatering devices such as Fourdrinier wire components, drainage foils or suction boxes can be used under the first wire in the pre-dewatering zone. Advantageously the components are so arranged that the negative pressure for dewatering increases at each successive point at which a stream of stock strikes the first wire, since each subsequent stream has to be dewatered through the mat of fibres already deposited from the preceding streams.

The dewatering pressure depends on the tension on the wire and the radius of curvature of

the curving zone, the curvature being determined by a roll shell. To prevent the full dewatering pressure being applied directly to the last stream of pulp, the curving zone is advantageously given an increasing curvature. In practice this can be done by providing a shoe having a convex curved surface in front of the dewatering roll, the curvature of the shoe being less than the curvature of the roll shell.

In order to adjust the dewatering zones for the individual stock streams within given limits, the partitions forming guides for the individual streams are preferably positioned at various places outside the outlet aperture of the headbox. In working the method it is of course essential that the partitions, the construction of which will be described later in detail, should have an adequate length. The length of course is graded depending on the required points of impact of the individual streams of stock.

The described method of sheet formation provides excellent facilities whereby individual streams of stock, which are guided close together to form a layered paper web, can be individually treated during the first dewatering and the immediately-following formation of sheets, so as to obtain sheets having specific, adjustable properties. More particularly, when the thickness of the web is increased, the pressure difference for dewatering can be increased stepwise, thus substantially combining the advantages of a flat wire or wet part and a double wire former.

According to a second aspect of the invention, a double wire former for a paper machine comprises headbox means having at least two separate stock supplies and a corresponding number of outlet apertures bounded by walls extending generally parallel to the flow and across the width of the headbox outlet apertures, partition components between the streams of stock and holding the streams apart for a distance downstream of the outlet apertures, and first and second endless wires which co-operate to partially surround a dewatering roll and, at the place where they touch the dewatering roll, form a converging gap for receiving the paper web under production, the first wire before arriving at the dewatering roll being guided over a pre-dewatering zone at the beginning of which there is at least one outlet aperture of the headbox means, and the partition components being constructed and mounted so that at the beginning of the pre-dewatering zone only the first stream adjacent the first wire strikes the first wire and at least the last partition component has a length such that the last stream, which it carries, is guided directly into the converging gap between the wires.

The pre-dewatering zone can be curved or straight. If it is straight it is advantageous to dispose a breast roll at the beginning of the pre-dewatering zone in conventional manner, in conformity with the construction of the headbox, the first wire being introduced into the pre-dewatering zone around the breast roll. The dewatering roll, which is surrounded by the two wires, can have a closed surface, e.g. of the kind used in tissue formers in which dewatering occurs substantially through the wire remote from the roll. Alternatively the dewatering roll can be covered with a grid-like lattice from which water is ejected on the side remote from the wire, or can be performed by bores, in which case a suction box can also be provided inside the roll. These constructions are preferably used in double wire formers for printing-paper. A grating or lattice on the roll, in contrast to blind bores, enables air to escape transversely from the water-absorbing recesses.

Advantageously, in order to be able to vary the converging gap between the two approaching wires, the guide roll guiding the second wire into the gap region is preferably adjustable as described in US-PS 4 176 005.

The partitions between the individual stock streams need to be constructed in a special manner, since they have to be relatively long in the aforementioned system. The pre-dewatering zone may quite possibly be given a length up to 150 cm, and the last partition usually has to extend over this entire length. Completely flexible partitions as described in US-PS 4 141 788 have the advantage of automatically adapting to the stream of stock, but if they are too long they may begin to vibrate or wobble. Preferably, therefore, the partitions are rigid walls inside the headbox channel and are substantially rigid surfaces outside the headbox apertures. If the partition walls inside the headbox channel are rigid, it does not matter whether a single headbox is used for the different streams of stock. Instead, the feed can be made up on the unit-construction principle of individual units for the various streams of stock. As a further alternative, one stock stream, preferably the last, can be supplied via a separate unit.

Preferably, a multi-stage diffuser headbox for a double wire former is used. When the quantities of liquid are large, a headbox of this kind usually has a number of rows of multi-stage diffusers in any case, and it is therefore easy to subdivide the adjacent headbox channel into a number of separate channels corresponding to the rows of diffusers, using fixed partition walls. Owing to their compact structure, however, independent single-row multi-stage diffuser units can be combined in a relatively narrow space to form a corresponding headbox system for a number of layers of web. Most webs need to have only two or three layers. Advantageously, when producing two-layer webs, each partition wall and adjacent partition surface forms a rigid unit outside the outlet aperture, but preferably both the outer-wall boundaries of the headbox channel are adjustable so that the individual jets of stock can be influenced accordingly. Even in a system for a three-layer web, it may be sufficient to use two rigid partition surfaces if the outer-wall boundaries of the headbox channel are adjustable. In the last-mentioned case the central stream of pulp can be adjusted via the amount of water, which will be

possible in many applications. Advantageously however, in the case of a system for a three-layer web, at least the top, second partition surface, which extends over a greater length, is made movable so as its position can be adjusted by external actuating means.

Movable partition surfaces are advantageously pivoted to the partition walls between individual channels near the outlet apertures of the headbox; the actual partition surfaces can be rigid. The partition surfaces can be pivotally secured a short distance outside the outlet apertures of the headbox, in which case they will be secured so that the partition surfaces can easily be replaced from outside the headbox.

In principle, pivotally mounted partition surfaces can be left freely adjustable in position between the streams of stock. If, however, the partition surfaces are relatively long, they are advantageously provided with external adjusting components. These components can be, for example, adjusting spindles or the like engaging directly and positively, for example, at the lateral ends of the partition surfaces, or alternatively can be purely non-positive components such as electromagnetic spacers. The spacers can be electrically powered bar magnets below the wire, preferably incorporated in a dewatering component and exerting repulsion on the permanent magnet in the partition surface, thus keeping it at a distance.

Since the last stream of stock in particular may have to travel a relatively long distance on the partition surface, it may be advantageous for at least part of the tops of the partition surfaces to be formed with structures producing microturbulence.

Insofar as the streams of stock and wires are curved, the partition surfaces, especially if rigid, must be given a corresponding profile.

The invention may be carried into pratice in various ways but a number of multi-ply machines embodying the invention and their mode of operation will now be described by way of example with reference to the accompanying diagrammatic drawings, in which:

Figure 1 is a diagram of the headbox and web-forming region of a double wire former suitable for the printing industry;

Figure 2 is a diagram of a double wire former for multi-ply tissue webs;

Figure 3*a* is a larger-scale diagram of the web-forming region of a further system similar to that shown in Figure 1;

Figure 3*b*, 3*c* are cross-sections on the planes X and Y shown in Figure 3*a* showing the cross-section of the partitions;

Figure 4 shows another embodiment of a double wire former for multi-ply webs;

Figure 5 shows another embodiment of a double wire former for a two-layer web;

Figure 6 is a diagram of a double wire former for multi-ply board webs with a separate headbox outlet aperture for the third layer of web — i.e. a secondary headbox, one of the partitions extending from the first headbox to the secondary headbox;

Figure 7 is a diagram corresponding to Figure 6, in which the second partition begins downstream of the first headbox; and

Figure 8 shows an embodiment corresponding to Figure 6 in which the second partition is secured at the secondary headbox.

Figure 1 is a fragmentary view of a double wire former having an inner wire or lower wire 1 which is guided round a breast roll 2, beyond which it extends over a substantially straight pre-dewatering zone 3 and wraps round part of a dewatering roll 4. An outer wire or upper wire 6 is guided from above around a guide roll 5 and along a path which extends above part of the lower wire 1, after which the wire 6 is guided so that it likewise wraps around part of the dewatering roll 4, so that a converging gap region 7 is formed between the lower wire and the upper wire at the inlet region. The guide roll 5 for the upper wire 6 is secured to an arm 8 which can pivot so as to vary the shape of the gap region 7 and lift the upper wire 6 away fromthe lower wire 1.

The term"first wire" and "second wire" will be used herein in the following sense; the first wire is that wire of the two wires in the double wire former on which the first layer of the stream of stock is pre-watered. The "first" wire in this sense can be either an upper wire, a lower wire, an inner wire or an outer wire, provided the technical arrangement is such that the first stream of stock coming into contact with a wire is pre-dewatered at the aforementioned first wire.The second wire is that on which the next dewatering occurs.

Various dewatering components are disposed below the straight pre-dewatering zone 3 of the lower wire 1. In the region immediately downstream of the breast roll 2, the components 9 comprise Fourdrinier wire components or drainage foils 10 with suction boxes 11 in the next region. A shoe 12 having a curved surface is disposed immediately in front of the place where the lower wire 1 engages the dewatering roll 4. The radius of curvature of the surface of the shoe 4 is greater than that of the roll 4. For a given wire tension, the dewatering pressure on the web in the curved region increases with the curvature of the guide. Accordingly it is advantageous to dispose a shoe having a smaller curvature than the roll in front of the roll, to prevent the dewatering pressure rising abruptly when the wire engages the roll 4.

In the illustrated example, the shoe 12 and the roll 4 curve in the same direction. Alternatively, however, it is quite possible for the wires to travel through a turning-point downstream of the curved shoe and then curve in the opposite direction when guided round the dewatering roll.

A multi-ply headbox 13 is disposed above and in front of the breast roll 2. In the example being described, the headbox is of the stepped diffuser kind. The headbox has three outlet apertures 14, 15, 16, which are bounded at the outside by two walls 17 and 18. The three outlet apertures are

separated from one another by partition walls 19 and 20. The discharge channels extending to the afore-mentioned three separate outlet apertures 14, 15, 16 are connected to independent stock supply devices 21, 22, 23. By way of example, rows of stepped diffusers, shown only as single through channels 24 in the drawing, can be disposed between the devices 21, 22, 23 and the discharge channels.

Downstream of the outlet apertures 14, 15 and 16, the rigid partition walls 19, 20 are joined directly to partitions 25, 26 which extend a considerable length downstream of the outlet apertures. Preferably, the partitions 25, 26 are also rigid and can be held in position by external retaining and adjusting components, not shown in the diagram. The upper partition wall 20 is pivotably mounted in the headbox channel, so that the cross-sections of the outlet apertures 15 and 16 can be varied relative to one another. As a rule, the ends of the walls 17, 18 bounding the outlet apertures are also adjustable, as a further means of influencing the flow of stock. These adjustment facilities can be used for adjusting the cross-sections of all three apertures 14, 15, 16 as required.

As clearly shown in Figure 1, the first stream of stock A coming from aperture 14 strikes the first wire (i.e. the lower wire 1 in the present case) at point I and is pre-dewatered mainly by the Fourdrinier wire components or drainage foils 10. Since the lower partition 25 extends far into the region in question, the second stream of stock B, which comes out of aperture 15, is for the most part dewatered only in the neighbourhood of the suction boxes 11. Up to a short distance in front of boxes 11, this stream is separated by the partition 25 from stream A and the layer of paper web already formed therefrom. The third and upper pulp stream C, which comes out of aperture 16, strikes the upper wire 6 at point II. Up to and beyond this point, however, it is separated from the two other streams or layers of paper web by the top partition 26, which extends into the gap region 7. It is only after passing the end of the partition 26 that layers B and C are dewatered together in the curving zone of the shoe 12 and the roll 4. It can be assumed that stream A has been fully formed into a web by this time.

The described system provides ample facilities for individually influencing the dewatering of the individual stock streams in the layered web. This is a great advantage, particularly where the web layers differ in quality and in their response to dewatering.

A system similar to Figure 1 is shown in Figure 3*a*, except that the drainage strips and suction boxes shown individually in Figure 1 are replaced by only a few diagrammatically indicated dewatering components 9. In Figure 3, the partitions 25′ and 26′ extend substantially the same distance into the gap region 7 between the wires 1 and 6, so that the streams B and C are not dewatered in the gap region 7 until the stream A has been substantially completely pre-dewatered in the pre-dewatering zone 3. Dewatering is brought about preferably on one side or alternatively on both sides, depending on the construction of the roll 4. If the roll 4 is a closed forming roll, dewatering in its direction can occur only to the extent to which the meshes of the lower wire 1 can absorb water. Alternatively, the roll 4 can be perforated and possibly equipped with suction boxes.

Another difference between the partitions 25′ and 26′ and the corresponding components in Figure 1 is that they have two reductions 27, 28 in cross-section or thickness. Up to and beyond the outlet apertures 14, 15, 16 the partitions 25′ and 26′ have the same cross-section as the walls 19, 20 of the headbox channel and thus provide a direct continuation thereof. The changes in cross-section of components 25′, 26′ at points 27 and 28 have a diffusing effect, similar to the known effect of stepped diffuser headboxes. As shown in Figures 3*b* and 3*c*, the outer edges of the partitions 25′, 26′ are joined to form a closed duct. As a result, the stream of stock B conveyed between them is kept isolated from streams A and C, even towards the edges of the web.

Figure 2 is a diagram of the complete Fourdrinier part of a double wire former for multi-ply tissue webs. Like parts are given the same reference numbers as the embodiment shown in Figure 1. In the present case the first wire is the inner wire 6.

Wires 1 and 6, as before, form endless loops and wrap round part of the circumference of the dewatering roll 4. The inner wire 6 is guided by additional guide rolls 29 and the main wire 1 is guided by additional rolls 30.

Downstream of the dewatering roll 4, the wires 1 and 6 form a substantially straight common portion leading to a separating device 31 comprising two rolls 32, 33, roll 33 also being a guide roll for the inner wire 6. The rolls 32 and 33 can both be solid, or alternatively roll 32 can be a suction roll as shown. After leaving the separating device 31, the wires 1 and 6 travel separately. The inner wire 6 has an obliquely upward portion below which there is a trough 34 which receives material displaced by wire-cleaning devices (not shown) disposed above the wire 6 in this region. The main wire 1 travels from the separating device 31 to a couching device 35 comprising one of the guide rolls 30 and a couch roll 36. A felt 37 is guided around the couch roll, which can be constructed as a suction roll. The felt 37 receives the paper web (not shown) from the wire 1 and conveys it to a drying end (not shown) of the machine.

A receiver 38 for water expelled in the curving zone extending around the roll 4 is disposed below the roll 4. A suction box 39 is disposed downstream of the receiver 38. An additional receiver 40 is disposed below the suction box 39 and is adapted to receive spray water and additional water coming from additional dewatering components (not shown) disposed near the suction box 39. Finally a receiver 41 is

disposed above the wire 6 behind the roll 4 and receives water ejected from the roll 4. There is room for the receiver 41, since both wires travel obliquely downwards after leaving the dewatering roll 4.

A multi-ply headbox 13, which can be constructed in similar manner to the headbox of the embodiment shown in Figure 1, is disposed above the wire 6 in front of the roll 4. In Figure 2 as before, the headbox has two outlet apertures separated by two partition walls directly connected to partitions 25 and 26. The lower partition 25 comes to an end before the wires touch the dewatering roll 4, but the upper partition 26 extends far into the gap region between the two wires, right into the region where the wires wrap round the dewatering roll 4. As before, the first stock jet strikes the first wire (the inner wire 6 in this case) at point I and is pre-dewatered by a diagrammatically-indicated dewatering component 9. The two remaining stock jets, which are held separate from one another by the partition 26, are not dewatered until they reach the gap region between the wires 1 and 6 or the curving zone of the dewatering roll 4. As before, reference II denotes the point at which the upper stock jet strokes the wire 1. Dewatering in the gap or curving zone occurs preferably outwards into the receiver 38. The receiver 41 receives water sucked from the wire meshes and ejected by the dewatering roll 4, which is constructed as a closed forming roll.

Figure 4 shows an embodiment of a double wire former for a two-ply web in which the second or inner wire is the shell of a suction roll which is also the dewatering roll. The lower wire 1, after being guided round a breast roll 2, travels through a relatively short, straight pre-dewatering zone 3, after which it is wrapped round part of a suction roll 44 above the wire and is then guided round a roll 30. The suction roll 44 has suction boxes 42 inside around more than half its periphery, so that after the wire 1 has moved away from the section roll the paper web (not shown) is held by the negative pressure of the suction boxes 42 and further dewatered on the suction roll, after which it is received for further treatment by a felt 43 co-operating with a couch roll 45, after the web has left the suction boxes 42 in the top part of roll 44.

Stock is supplied by a double layer headbox 46 which, apart from the outer boundary walls 19 and 20 has only one inner partition wall 47 which outside the outlet aperture merges into a partition component 48 which extends into the gap region between the wire 1 and the shell of the suction roll 44. The bottom or first stock stream A strikes the first wire (wire 1 here) at point I and is dewatered down through the wire 1 in the substantially straight pre-dewatering zone 3. The second or top stock stream B strikes the suction-roller shell at point II and, up to a short distance after this point, is separated by the partition component 48 from the bottom stream A or the web formed therefrom. Stream B is subsequently dewatered exclusively upwards through the suction roll 44.

The embodiment in Figure 5 shows a similar system comprising a headbox for a two-ply web. As before, two wires are used and together wrap round a dewatering roll — an open roll in the present case. In Figure 5, dewatering components 49 are disposed under the pre-dewatering zone 3 of the wire 1 and substantially pre-dewater the bottom stream A in this region. Since the dewatering roll 50 is not a suction roll but is open, the top stream B, after leaving the end of the partition 48, is dewatered both outwards through the wire 1 and the web ply previously formed from stream A and also inwards through the wire 6 and the shell of the roll 50. This dewatering of stream B in both directions is indicated by arrows B_1 and B_2.

Figures 6 to 8 diagrammatically show a double wire former used mainly for producing multi-ply board. The bottom wire 1 is basically a normal Fourdrinier, in that it winds round a breast roll 2, from which it extends over dewatering components comprising wet-machine components or drainage foils 10 and suction boxes 11, 51 and is thence guided round a suction roll 52 and back via guide rolls 30 to the breast roll. Downstream of the suction roll 52, a couch suction roll 36 takes the paper web (not shown) from the wire 1 on to a felt 37. The double wire system is disposed in the region between the suction-box units 11 and 51, where a second or top wire 6 is brought from above down to the bottom wire 1. The wire 6 is guided around roll 29.

A two-ply headbox 46 is disposed downstream of the breast roll 2 and above the wire 1 and has top and bottom walls 18, 17 bounding the stock feed channel and an intermediate partition wall 47, the walls co-operating to bound two outlet apertures 53, 54. Downstream of the apertures 53, 54, the partition wall 47 continues in the form of a partition component 48, which extends as far as the suction boxes 11. The bottom or first flow A coming from aperture 53 is pre-dewatered or formed by the wet-machine components or drainage foils 10 and some of the suction boxes 11 on the first or bottom wire 1, before the second stream B emerging from aperture 54 has been pre-dewatered in the remaining region of the suction boxes 11, downstream of the end of the partition component 48.

A secondary headbox 55 having a single outlet aperture 56 from which the top and last stream C emerges is disposed downstream of the end of the group of suction boxes 11 and in front of the inlet region of the double wire system. Downstream of the headbox 55, the two adjacent wires 1, 6 wind with slight curvature round a dewatering device 57 inside the top wire and likewise comprising suction boxes if required. Downstream of the device 57, the wires are guided round a curve in the opposite direction and wrap through a defined angle around a dewatering or forming roll 4 disposed inside the bottom wire 1. The wires are guided round the roll 4 by an adjacent guide roll 58 in the top wire. After leaving the roll 58, the

wires curve in the opposite direction round a guide roll 59 inside wire 1, after which the wire 6 turns back around one of its guide roll 29 and the wire 1 bearing a paper web (not shown) is guided over the suction boxes 51.

In this system the curving zone, which produces a dewatering pressure, and through which the two wires are guided together in abutting relationship, comprises a number of portions curving in alternate directions. As before, however, the curvature progressively increases, thus increasing the dewatering pressure. The surface of the dewatering device 57 is only slightly curved whereas the shell of roll 4 is more strongly curved. Guide rolls 58, 59, which are still smaller in diameter and therefore still more strongly curved, bring about additional dewatering.

The system has a special feature, i.e. an additional partition component 60 which is pivoted at a point 61 to the top wall 18 of the headbox 46 and upwardly bounds the second stock stream B. The component 60 extends over the entire pre-dewatering zone 3 to the secondary headbox 55 and on to the gap region between the wires 1 and 6, thus holding the stream C separate from the two webs previously formed from streams A and B, right up to the dewatering devices 57. This system, if the dimensions of the partition component 60 and the dewatering conditions are appropriate, has the advantage that the stream C, which strikes the wire 6 at point II, need not be brought directly into contact with the previously-formed web layers A and B, but can itself be pre-dewatered to a certain extent, so that when layer C is brought together with layers A and B they have been dewatered to about the same extent. This prevents the previously-formed layers A and B being destroyed by stream C, and in addition the dewatering can be controlled so that when the layers are brought together they are in a state requiring further dewatering in the double wire region; the resulting transverse streams of liquid improve the felting and bonding between the individual layers of web without appreciable mixing between the layers of fibrous material. This system therefore has an advantage, particularly in the production of board, over those Fourdrinier systems in which ready-formed and largely pre-dewatered web layers are simply couched together.

The embodiment shown in Figure 7 is similar to that shown in Figure 6, the only difference being that the continuous partition component 60 is replaced by a partition component 60′ secured to a stationary support 62 independent of the headbox 46 and disposed downstream of the outlet aperture 54. Jet B, after leaving the aperture 54, is not initially bounded at the top, but then enters a region where it is bounded by the two partitions 46 and 60′. Finally, Figure 8 shows an embodiment comprising a partition component 60″ which extends from the bottom boundary wall 63 of the secondary headbox 55. In this case, therefore, stream B has a free upper surface as it moves from the first headbox 46 to the secondary headbox 55, which it reaches before travelling under the partition component 60″, which keeps it separate from stream C for a further given distance.

In the embodiment shown in Figures 6 and 7, components 60 and 60′ are the main components which upwardly bound the second stock stream over a relatively long distance. Advantageously, therefore, they are given surfaces producing microturbulence in the stock stream, to prevent flocculation of or the formation of flakes in the stock in the part of the flow before any dewatering has occurred.

Advantageously the partition components are supported by means (not shown) along their length and are either secured in a completely rigid manner or are secured by devices which permit their positions to be adjusted.

CLAIMS

1. A method of forming a multi-ply paper web in a double wire former comprising first and second endless wires, parts of the wires pressing together under tension and travelling through a curving zone producing a dewatering pressure and forming a converging gap at the inlet to the curving zone, the gap receiving a paper web being manufactured, and at least two streams of stock emerging separately from headbox outlet apertures and being guided in substantially neighbouring layers and kept separate from one another by partition components extending in the flow direction downstream of the outlet apertures, at least the first stock flow adjacent a first of the two wires being pre-dewatered at the first wire without action by the second wire and by the dewatering pressure of the curving zone to form a completed layer of paper web, and at least the last stock stream, which is guided by the last partition component and is not externally bounded by a partition component being dewatered by being inserted directly into the converging gap region formed by the wires.

2. A method as claimed in Claim 1 in which the first stream and the other stream or streams are pre-dewatered at the first wire.

3. A method as claimed in Claim 1 or Claim 2 in which the pre-dewatering at the first wire occurs substantially under the natural static and dynamic pressure of the heads of liquid in the streams of stock.

4. A method as claimed in Claim 1 or Claim 2 in which the pre-dewatering at the first wire is effected at least partly by dewatering devices located on the opposite side of the wire from the streams of stock.

5. A method as claimed in any of the preceding claims in which at least the last stream and the web formed at least from the first stream are subjected to an increasing dewatering pressure in a zone of increasing curvature.

6. A method as claimed in any of the preceding claims in which the streams are held separate from one another by substantially rigid partition components.

7. A method as claimed in any of the preceding claims in which the individual streams are guided by partition components outside the outlet apertures.

8. A double wire former for a paper machine comprising headbox means having at least two separate stock supplies and a corresponding number of outlet apertures bounded by walls extending generally parallel to the flow and across the width of the headbox outlet apertures, partition components between the streams of stock and holding the streams apart from a distance downstream of the outlet apertures, and first and second endless wires which cooperate to partially surround a dewatering roll and, at the place where they touch the dewatering roll, form a converging gap for receiving the paper web under production, the first wire before arriving at the dewatering roll being guided over a pre-dewatering zone at the beginning of which there is at least one outlet aperture of the headbox means, and the partition components being constructed and mounted so that at the beginning of the pre-dewatering zone only the first stream adjacent the first wire strikes the first wire and at least the last partition component has a length such that the last stream, which it carries, is guided directly into the converging gap between the wires.

9. A double wire former as claimed in Claim 8 in which the first wire is guided by a breast roll substantially in a straight line through the pre-dewatering zone.

10. A double wire former as claimed in Claim 9 in which the pre-dewatering zone includes dewatering devices located beneath the first wire.

11. A double wire former as claimed in Claim 9 or Claim 10 in which a shoe having a convex curved surface is disposed upstream of the dewatering roll below the first wire, its curvature being less than the curvature of the dewatering roll and the shoe being at least partly surrounded by the second wire.

12. A double wire former as claimed in Claim 8 in which the first wire is guided round a forming roll in the pre-dewatering zone.

13. A double wire former as claimed in any of Claims 8 to 12 in which the dewatering roll has a closed surface.

14. A double wire former as claimed in any of Claims 8 to 12 in which the dewatering roll has a lattice disposed on its shell.

15. A double wire former as claimed in Claim 14 in which the dewatering roll also contains a suction box.

16. A double wire former as claimed in any of Claims 8 to 15 in which the second wire, before meeting the first wire, is guided around an adjustable-position guide roll for adjusting the converging inlet gap.

17. A double wire former as claimed in any of Claims 8 to 16 in which the partition components between the individual streams of stock are constructed as rigid partition surfaces.

18. A double wire former as claimed in Claim 17 in which the downstream ends of the partition surfaces are pivotally secured to the headbox means.

19. A double wire former as claimed in Claim 18 which includes adjustable means for positioning the partition surfaces.

20. A double wire former as claimed in Claim 19 in which the adjusting means are positively-operating mechanical components.

21. A double wire former as claimed in Claim 19 in which the adjusting means are non-positively acting components.

22. A double wire former as claimed in any of Claims 18 to 21 in which the pivotally-secured partition surfaces are constructed so that they can be replaced from outside the headbox means.

23. A double wire former as claimed in any of Claims 17 to 22 in which the partition surfaces have a curvature corresponding to the wire guides.

24. A double wire former as claimed in any of Claims 17 to 23 in which at least a part of the partition surfaces is given a structure producing micro-turbulence.

25. A double wire former as claimed in any of Claims 17 to 24 in which at least two of the outlet apertures of the headbox means are adjacent outlet apertures of a multi-layer headbox having adjacent boundary walls forming a common partition wall directly adjacent a partition component.

26. A double wire former as claimed in Claim 25, for a two-ply web, in which a single partition surface, ridigly connected to the single partition wall, is provided and the two outer boundary walls of the outlet apertures are adjustable in order to adjust the jet.

27. A double wire former as claimed in Claim 25, for a three-ply web, in which the partition wall and the partition surface adjacent the first wire have a rigid construction, the second partition surface and/or the associated partition wall are pivotally secured and the outer boundary walls are adjustable.

28. A double wire former as claimed in Claim 25, for a three-ply web, in which the two partition walls and/or partition surfaces are joined at their outer edges to form a channel-like unit.

29. A double wire former as claimed in any of Claims 17 to 24, for a three-ply web, in which the outlet aperture for the last pulp stream is disposed downstream of the outlet apertures for the first two streams at a place at which the layer of web has not been completely formed from the second stream.

30. A double wire former as claimed in Claim 29 in which the partition component for separating the second stream from the third stream begins at a place downstream of the outlet apertures for the first stream and the second stream.

31. A double wire former as claimed in any of Claims 17 to 30 in which adjacent partition components enclosing one stream have a cross-section such that the stream has abrupt changes in cross-section.

32. A method of forming a multi-ply paper web

substantially as described herein with reference to any one of Figures 1, 2, 4, 5, 6, 7 and 8 or to Figures 3*a*, 3*b* and 3*c* of the accompanying drawings.

33. A double-wire former for a paper machine, the former being constructed and arranged to operate substantially as described herein with reference to any one of Figures 1, 2, 4, 5, 6, 7 and 8 or to Figures 3*a*, 3*b* and 3*c* of the accompanying drawings.

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